

Fourth Annual Conference on Carbon Capture & Sequestration

*Developing Potential Paths Forward Based on the
Knowledge, Science and Experience to Date*

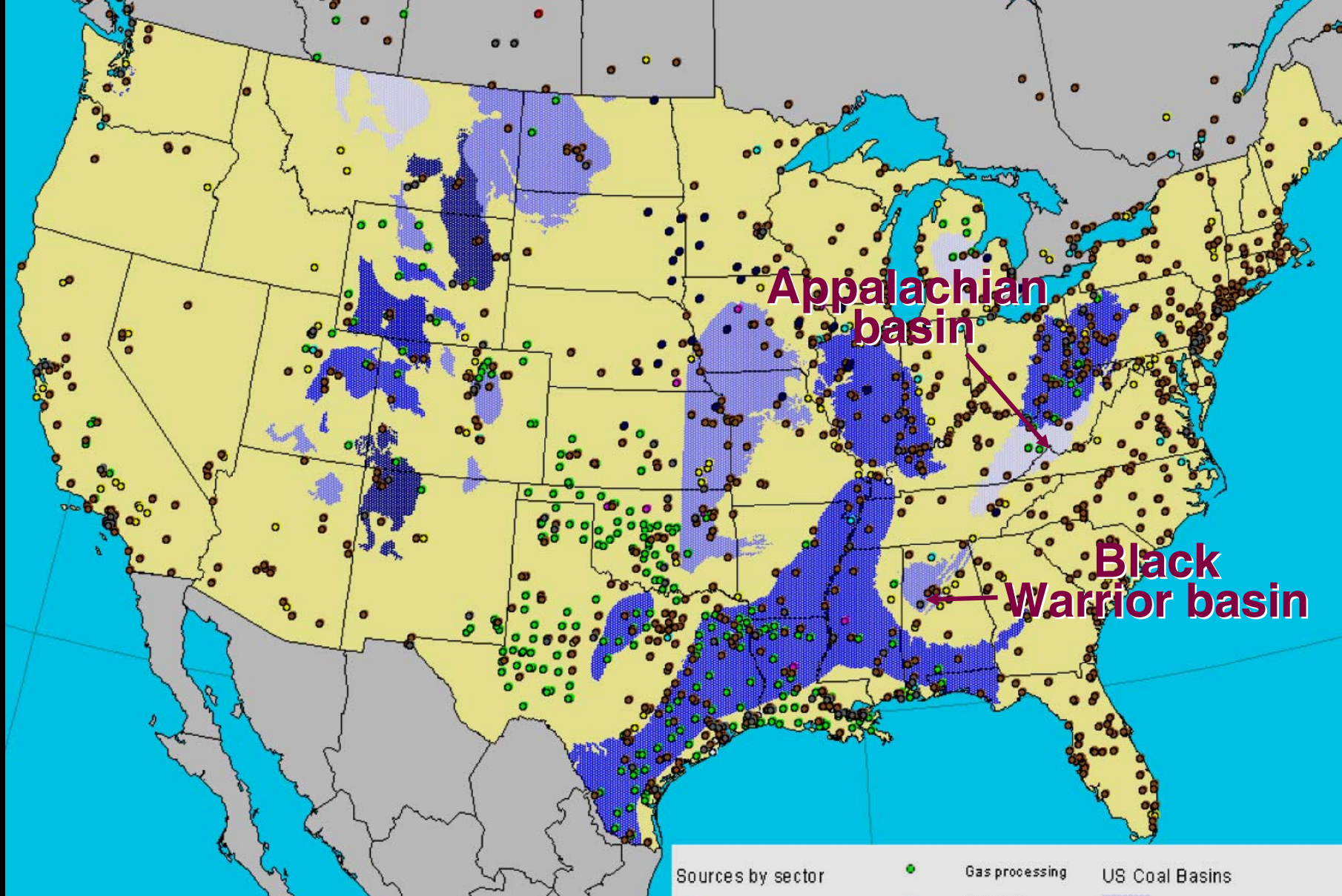
Geologic - Coal Seams (2)

Heterogeneous Permeability in Appalachian Coal: Implications for Carbon Sequestration and Enhanced Coalbed Methane Recovery

Jack C. Pashin, Richard E. Carroll - Geological Survey of Alabama
J. Matthew Conrad, Michael J. Miller - Marshall Miller and Associates
Michael T. Karmis, Nino Ripepi - Virginia Tech

May 2-5, 2005, Hilton Alexandria Mark Center, Alexandria Virginia





Sources by sector

- Ammonia
- Cement
- Ethanol
- Ethylene
- Ethylene oxide

- Gas processing
- Hydrogen
- Iron & steel
- Oil Sands
- Power
- Refineries

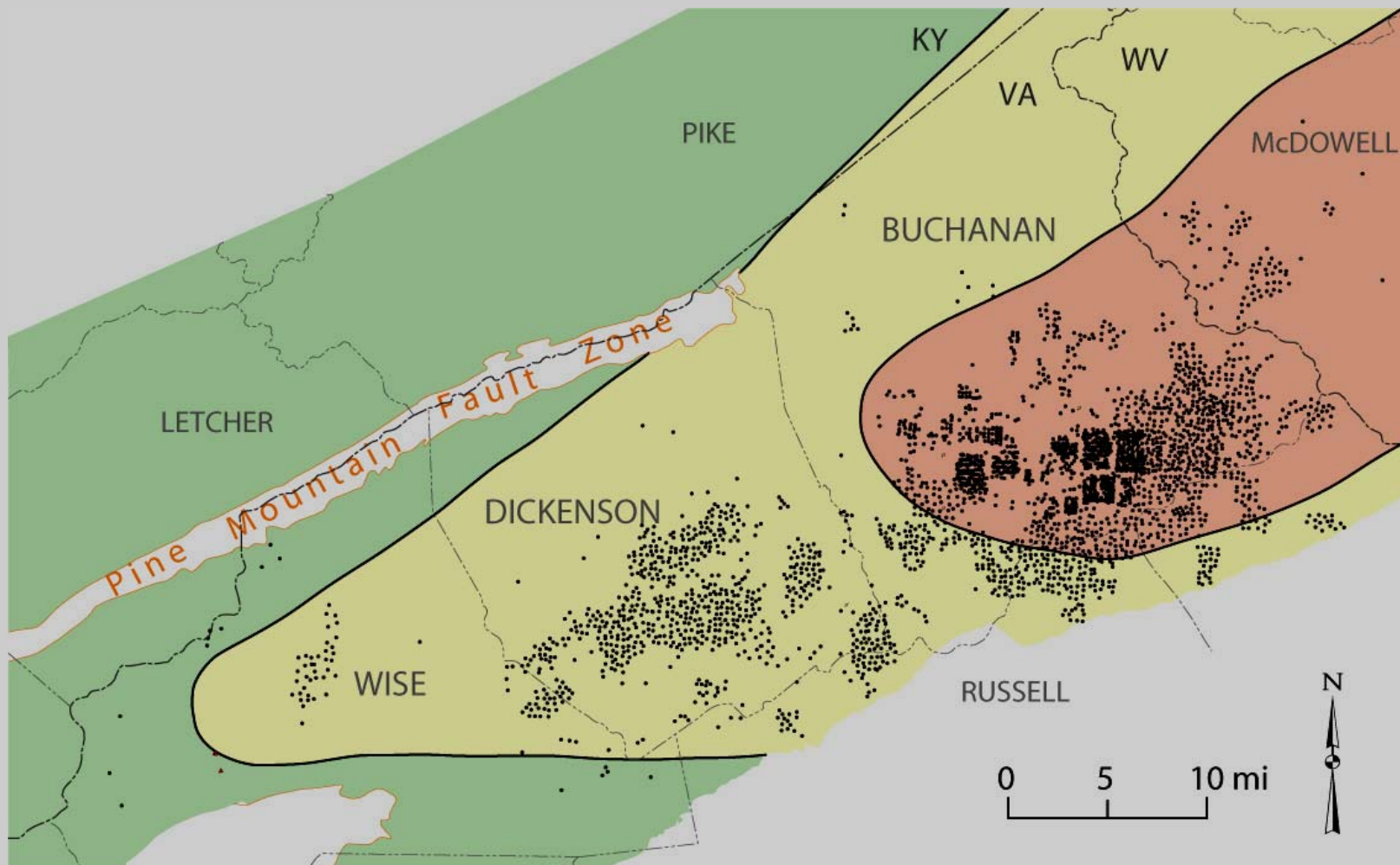
US Coal Basins

- 1 - 100 MtCO₂
- 100 - 1000 MtCO₂
- 1000 - 5000 MtCO₂
- 5000 - 10000 MtCO₂
- 10000 - 15000 MtCO₂

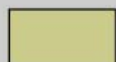
US Source-Sink Match

Gale, 2004

VIRGINIA CBM DEVELOPMENT



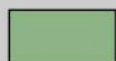
COAL RANK



Medium volatile bituminous



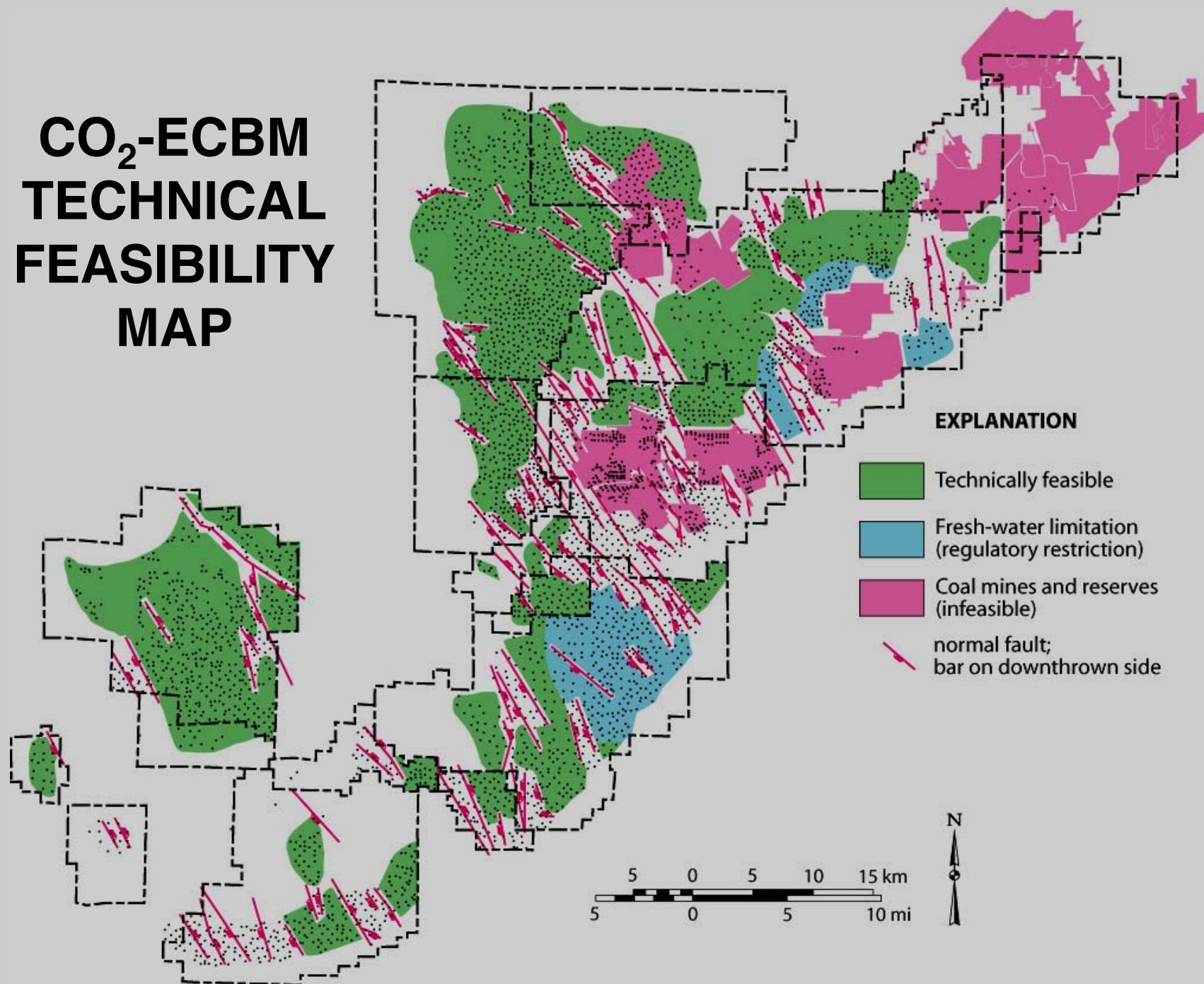
Low volatile bituminous



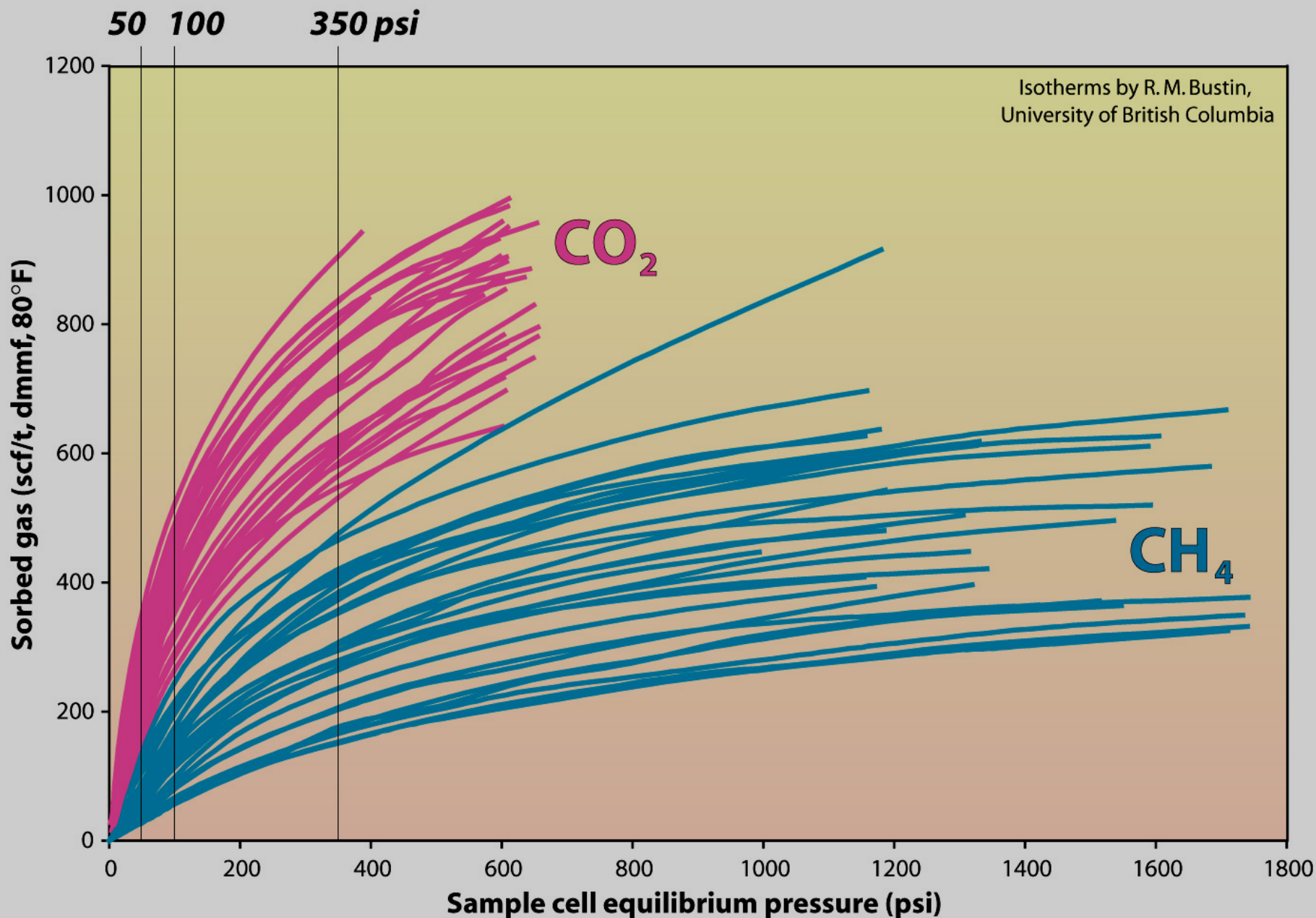
High volatile bituminous

· Coalbed methane well

CO₂-ECBM TECHNICAL FEASIBILITY MAP



POTTSVILLE ISOTHERMS, ALABAMA



Core log	Well log	Coal zone
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GR Density

- FS

500 ft.

Utle

-FS

1000

Gwin

FS

1500

Cobb

FS

2000

Pratt

FS-

2500

Gillespy





FS-

3000

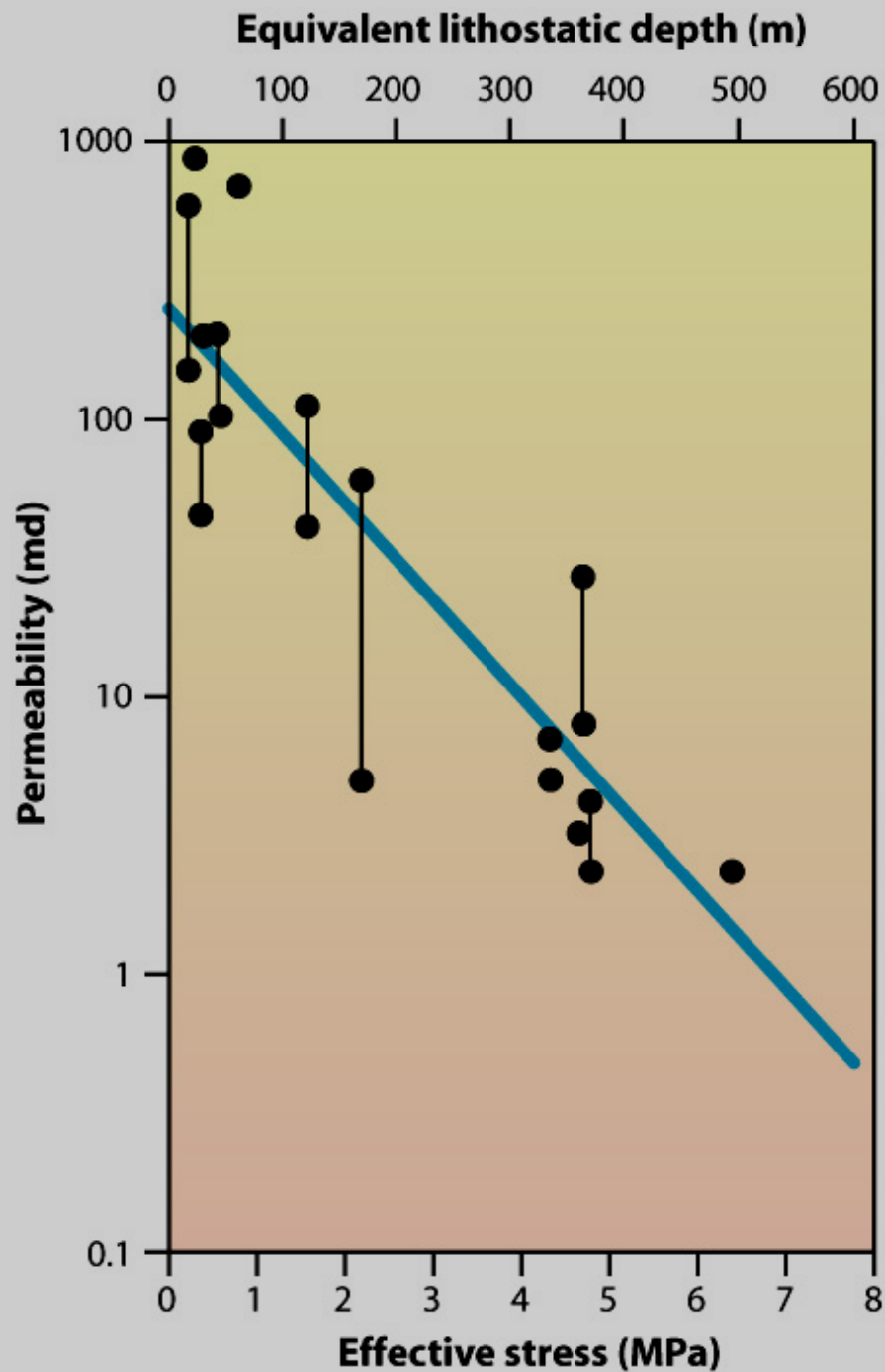
Mary Lee

FS-

Ream

- | | |
|---|-------------------------|
|  | Coal |
|  | Sandstone, conglomerate |
|  | Terrestrial mudstone |
|  | Marine mudstone |

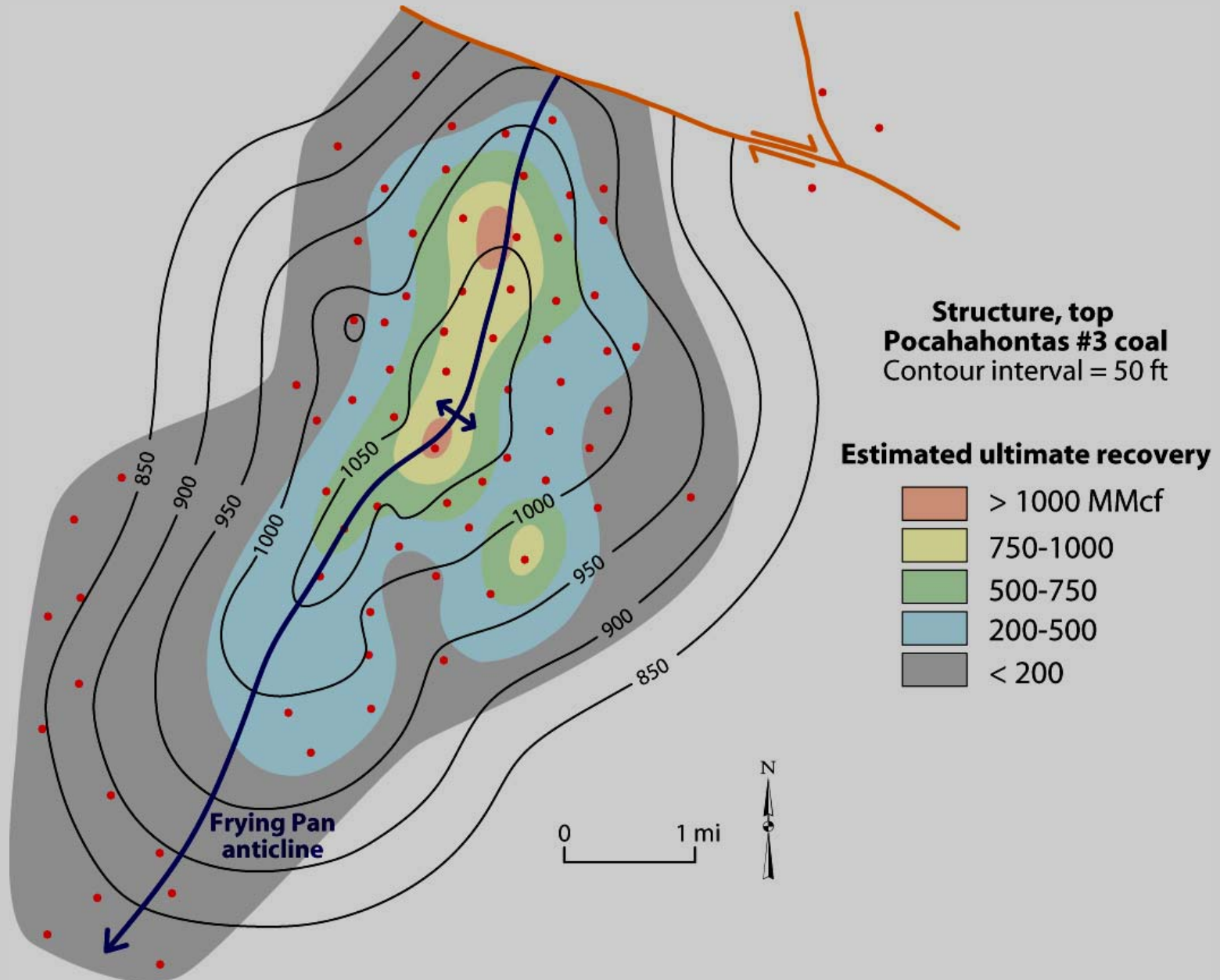
**FS - Maximum flooding surface
(4th-order parasequence boundary)**



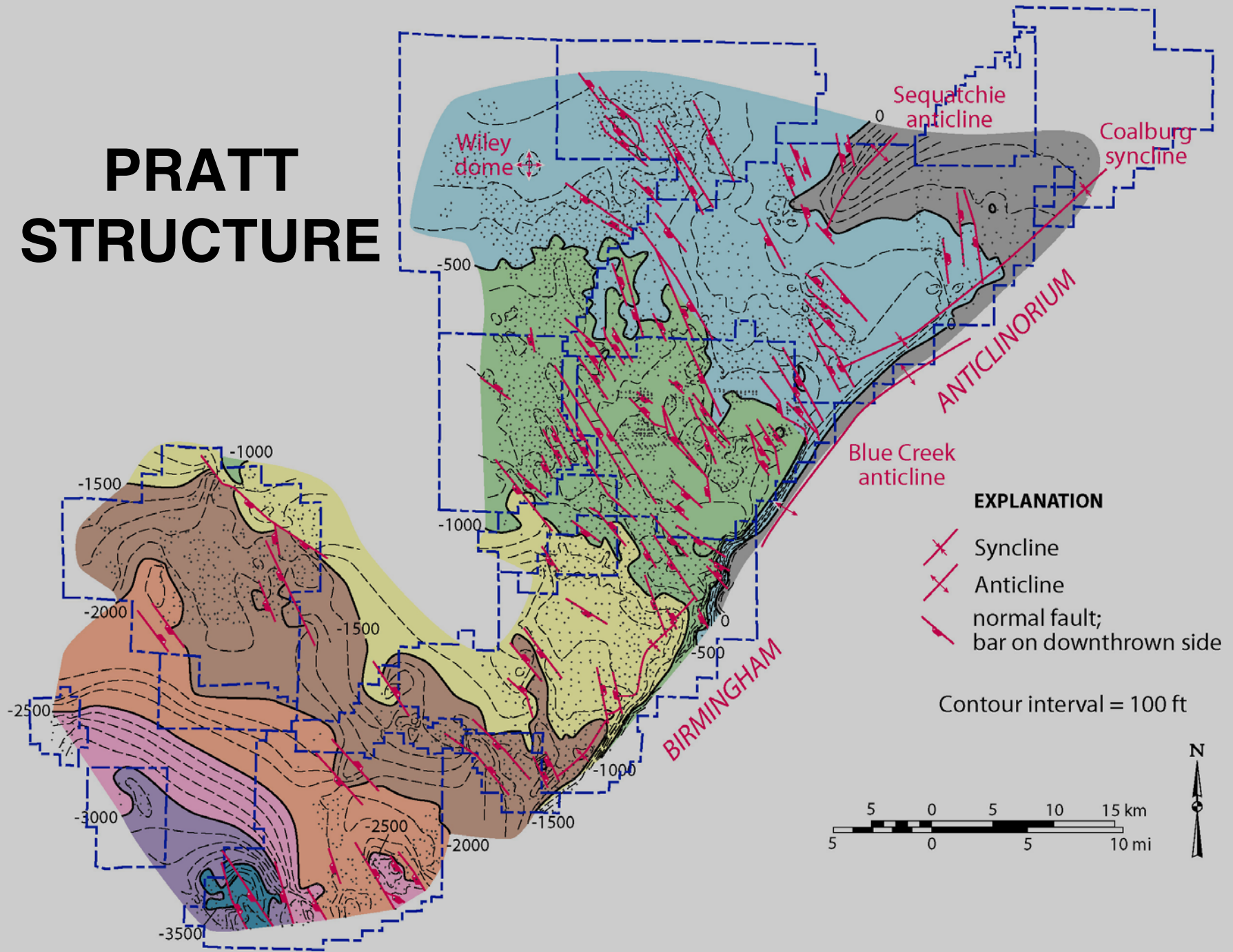
PERMEABILITY-DEPTH RELATIONSHIP BLACK WARRIOR BASIN

McKee et al., 1988

ANTICLINE, NORA FIELD, VIRGINIA



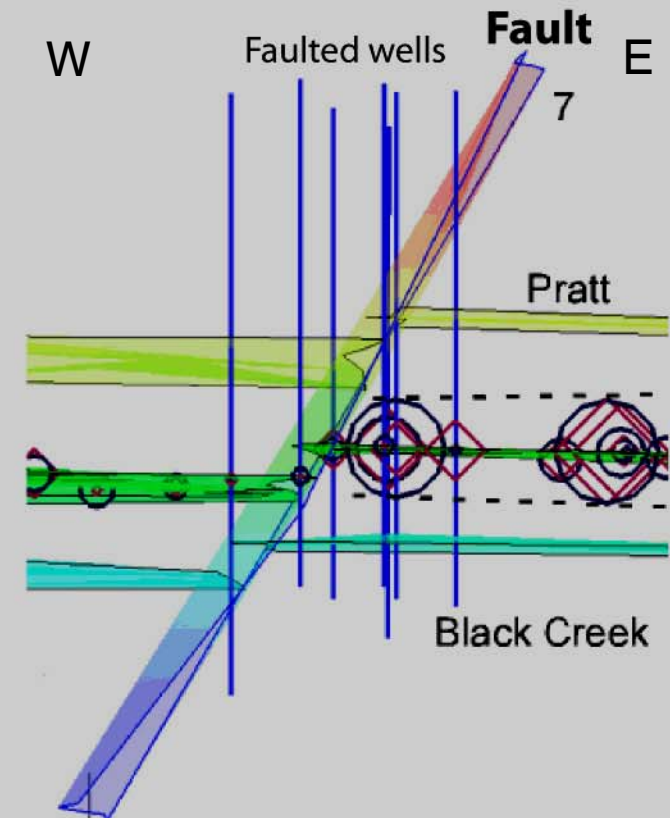
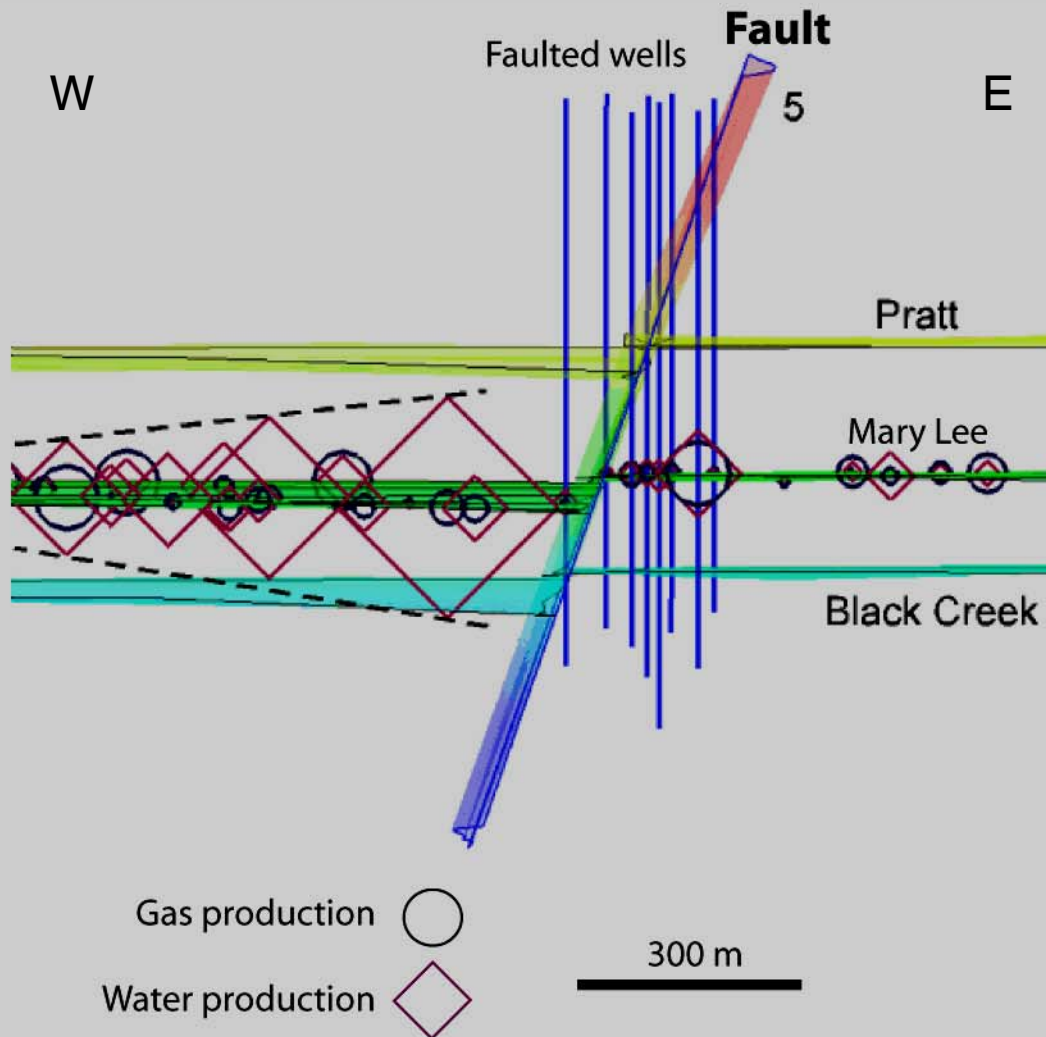
PRATT STRUCTURE



FAULTING AND FRACTURING



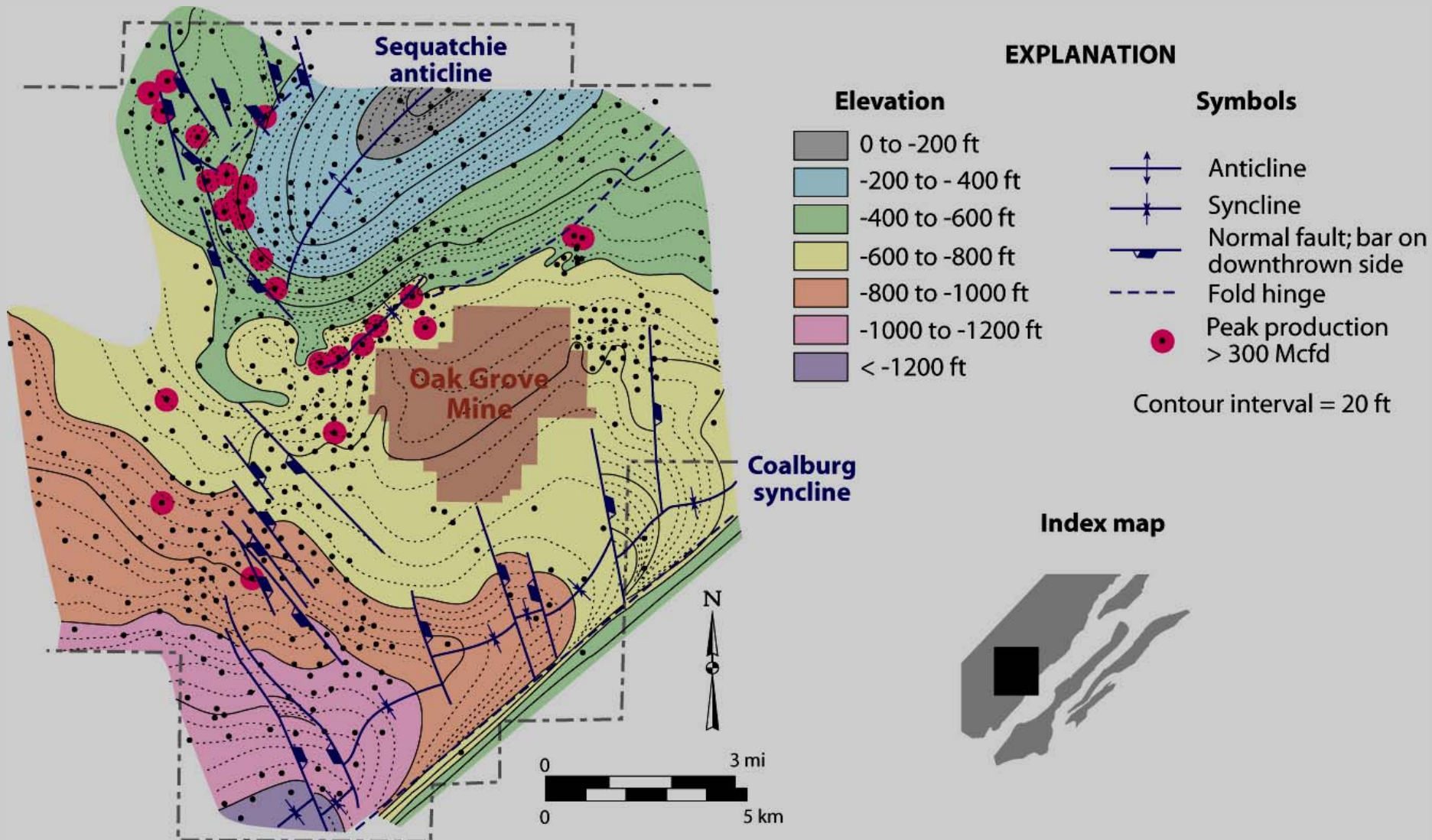
PRODUCTION AND FAULTS, ALABAMA



modified from Groshong et al. (2003)

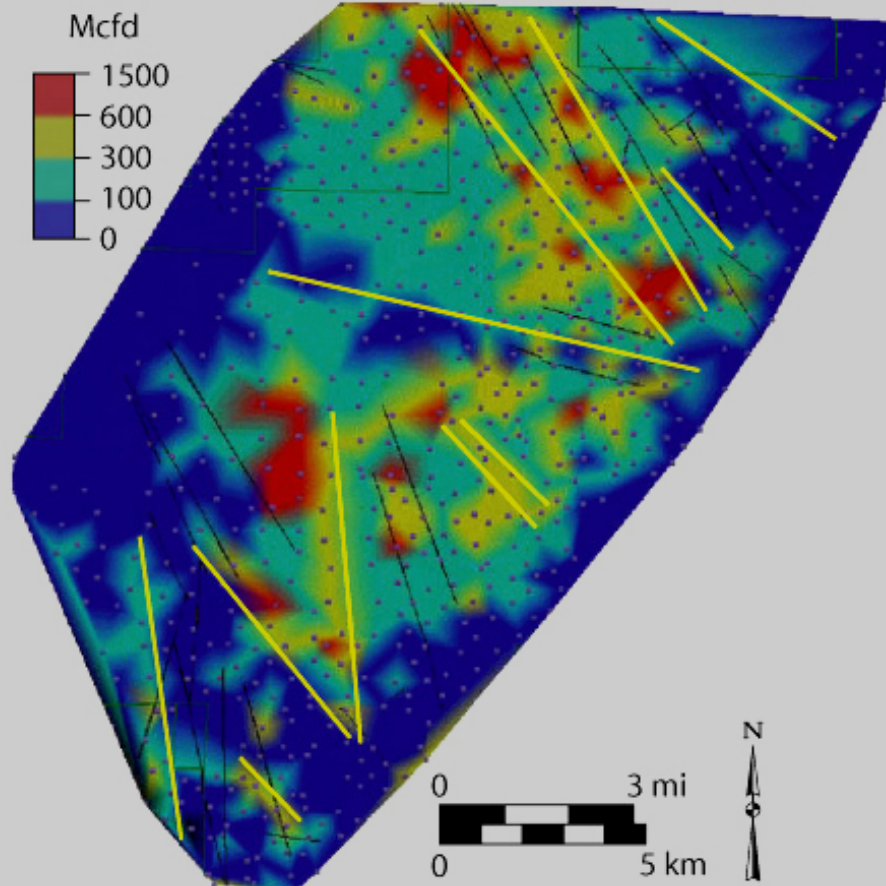
SEQUATCHIE STRUCTURE

OAK GROVE FIELD

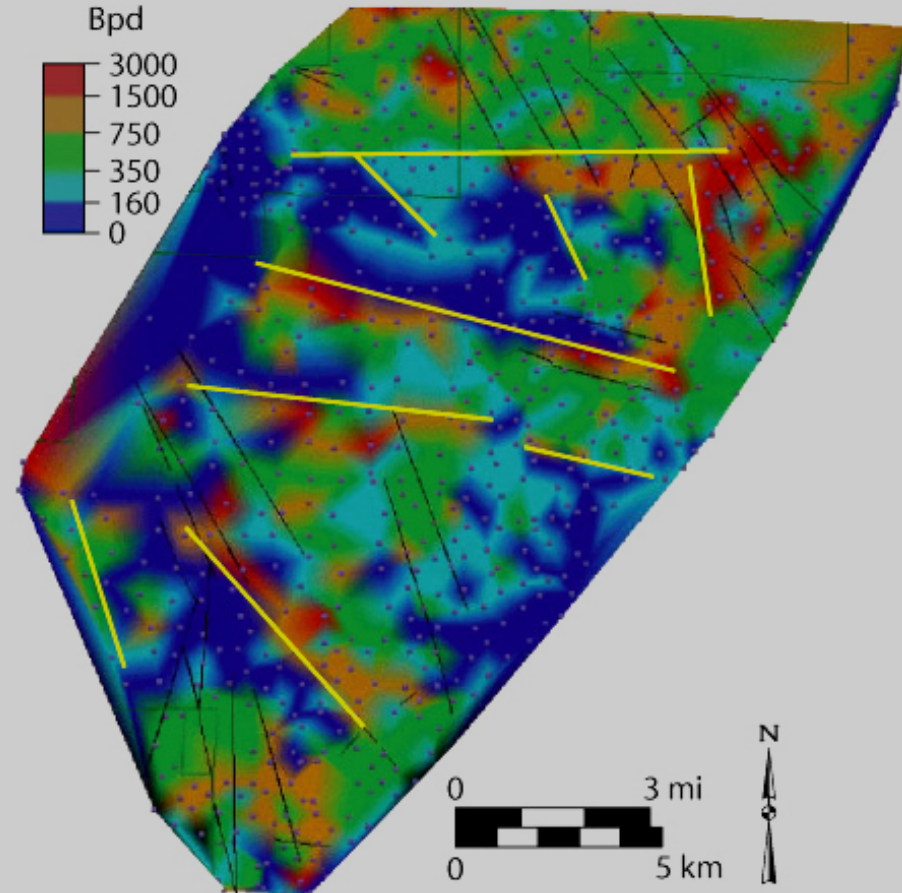


LINEAR PRODUCTION TRENDS

Linear gas production trends

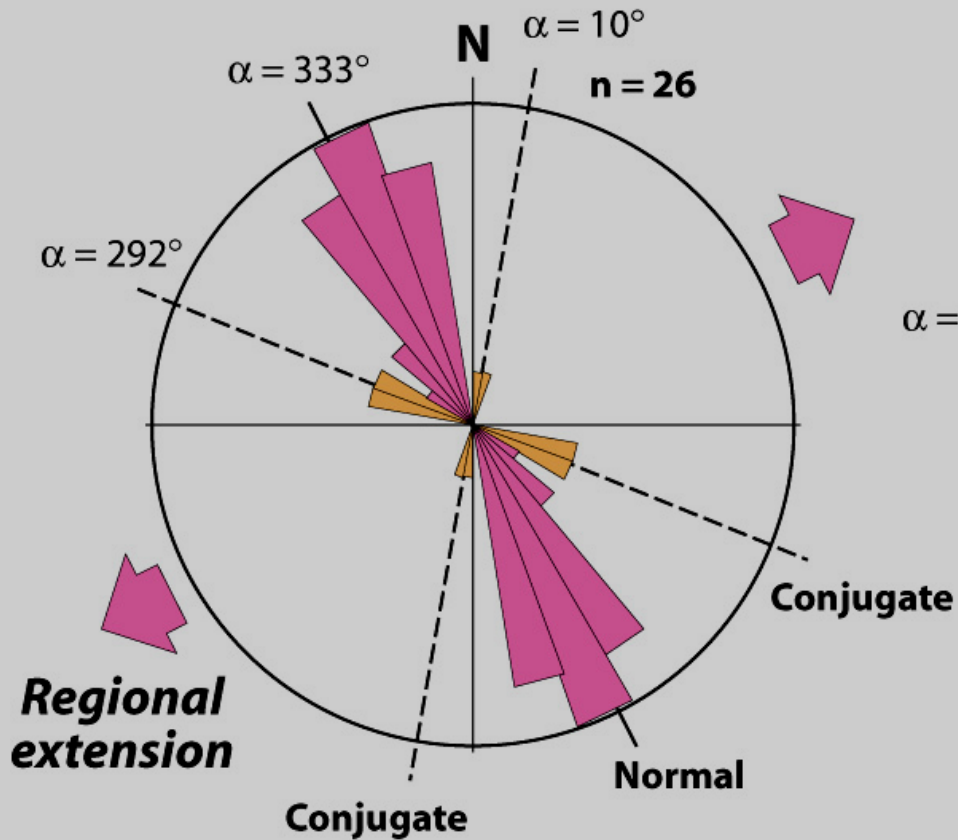


Linear water production trends

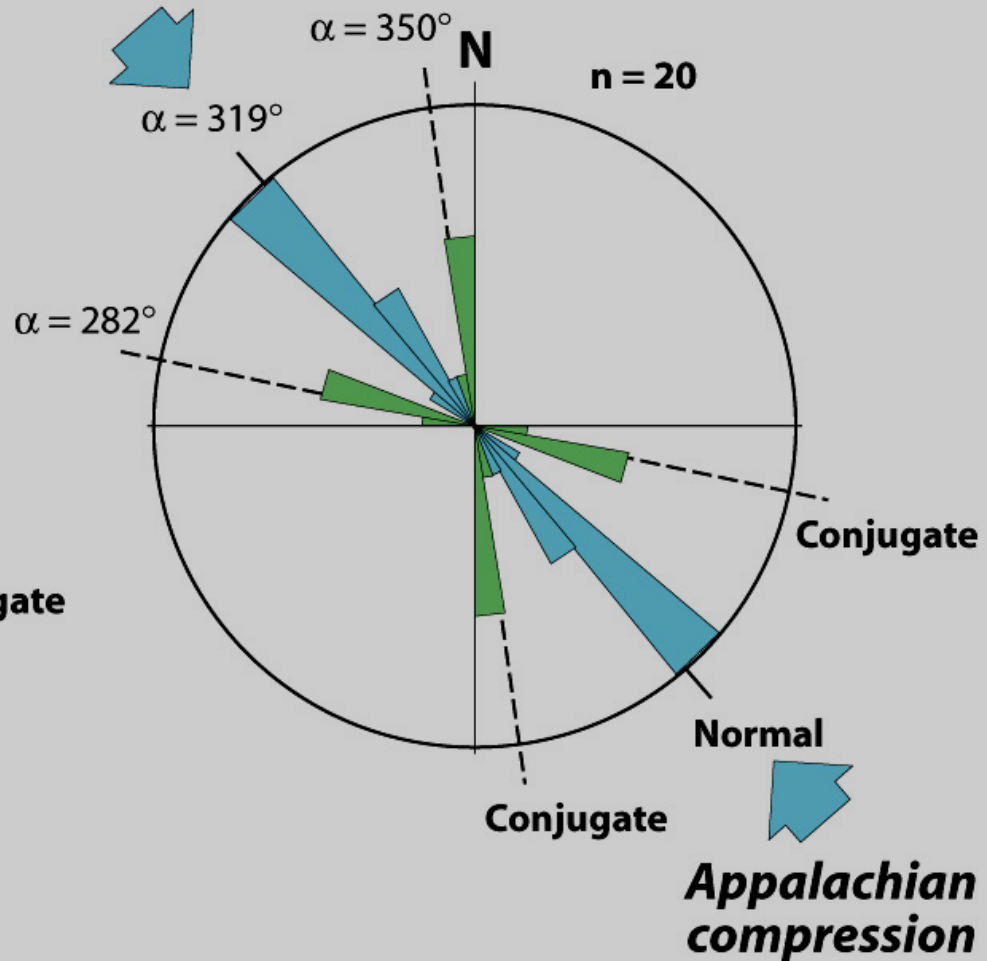


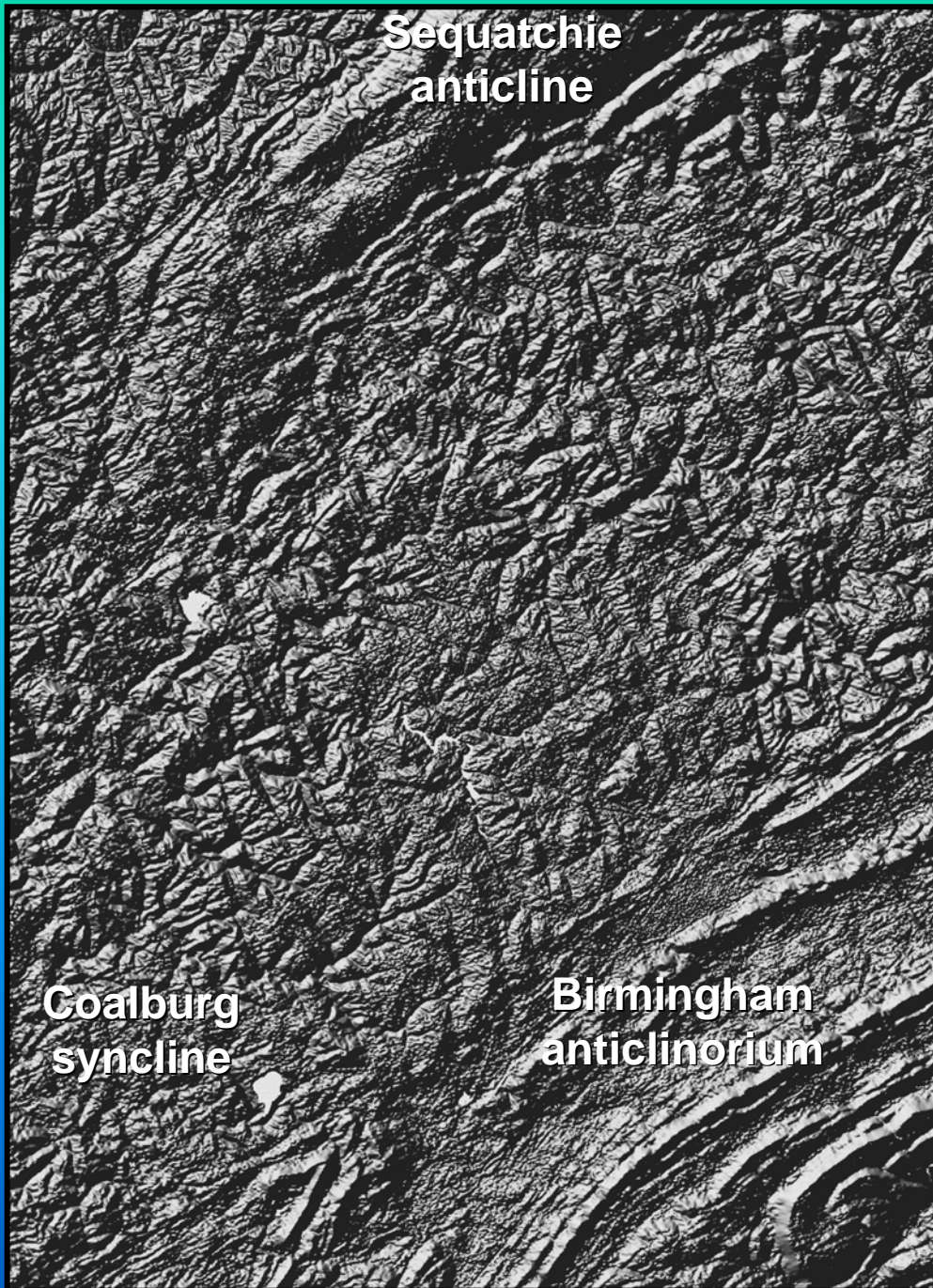
ROSE DIAGRAMS

NORMAL FAULTS



LINEAR PRODUCTION TRENDS





COALBURG SYNCLINE

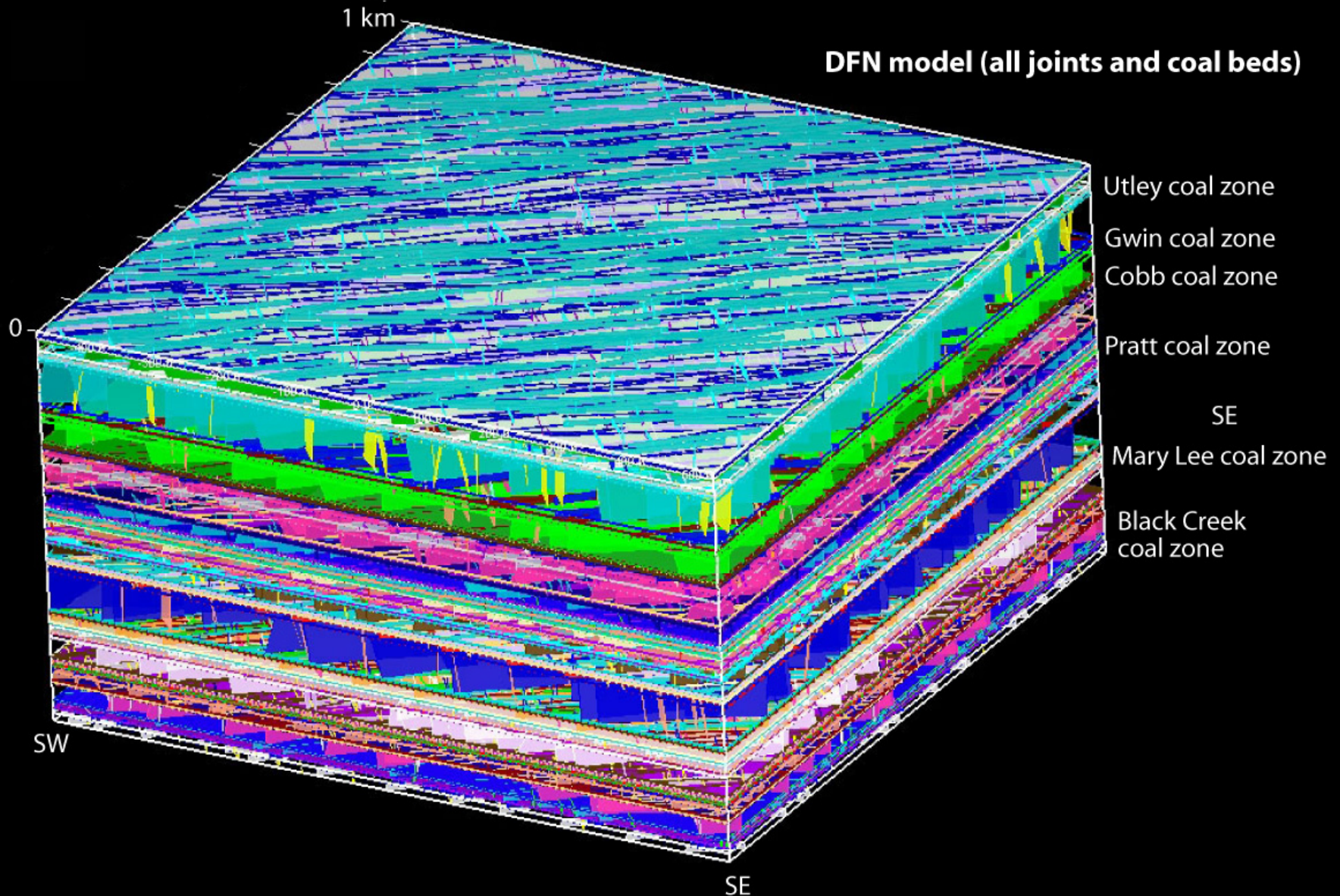
Shaded
DEM



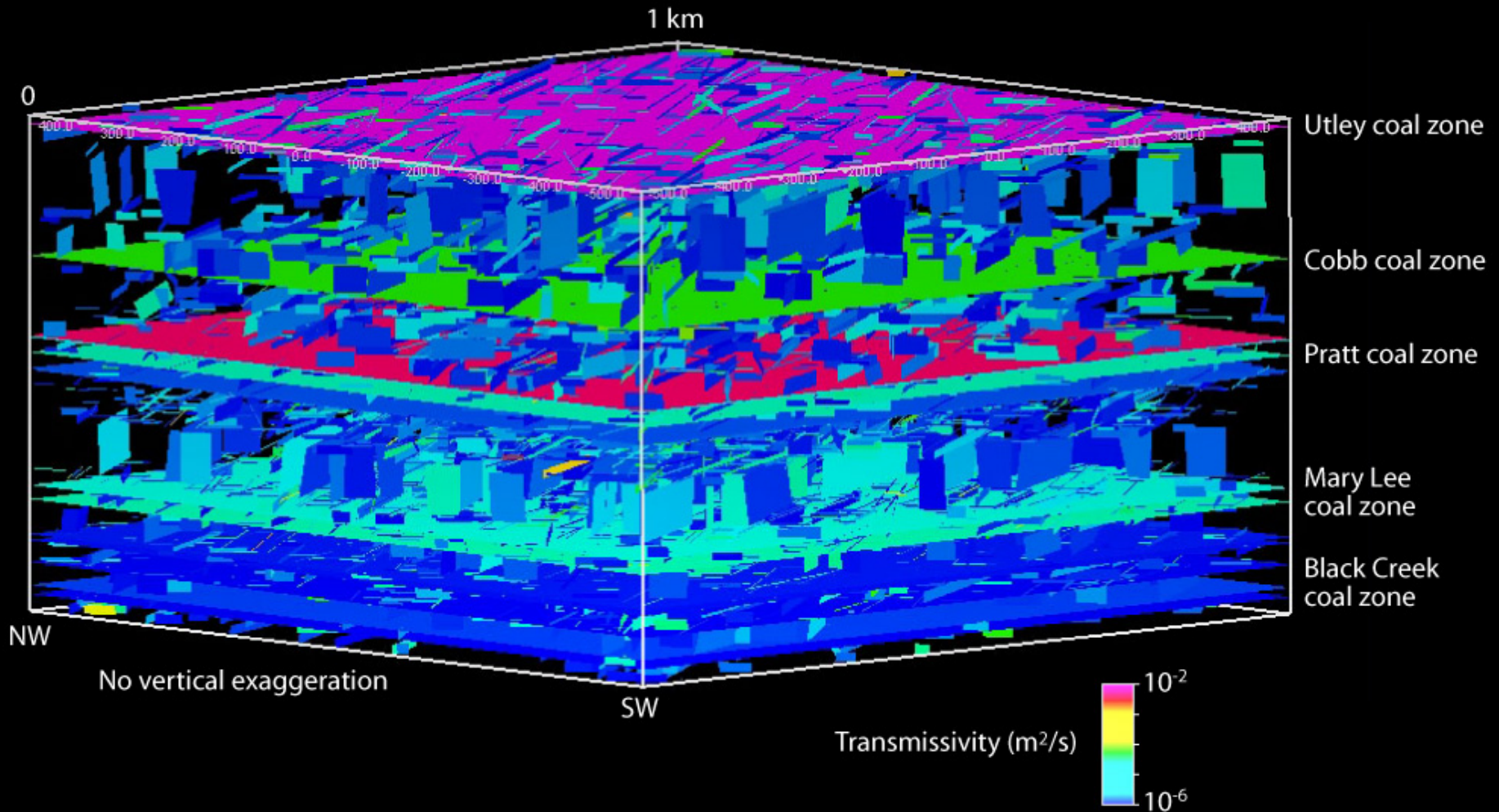
5 km



JOINTED DFN MODEL

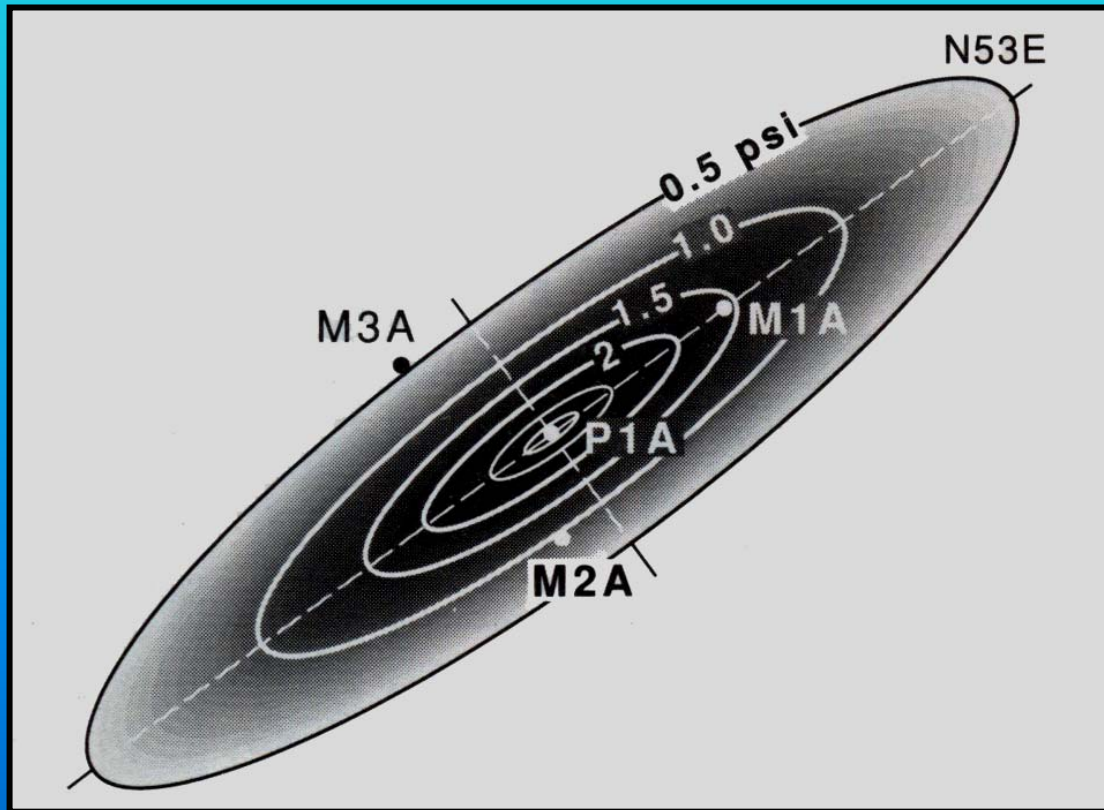


TRANSMISSIVITY MODEL

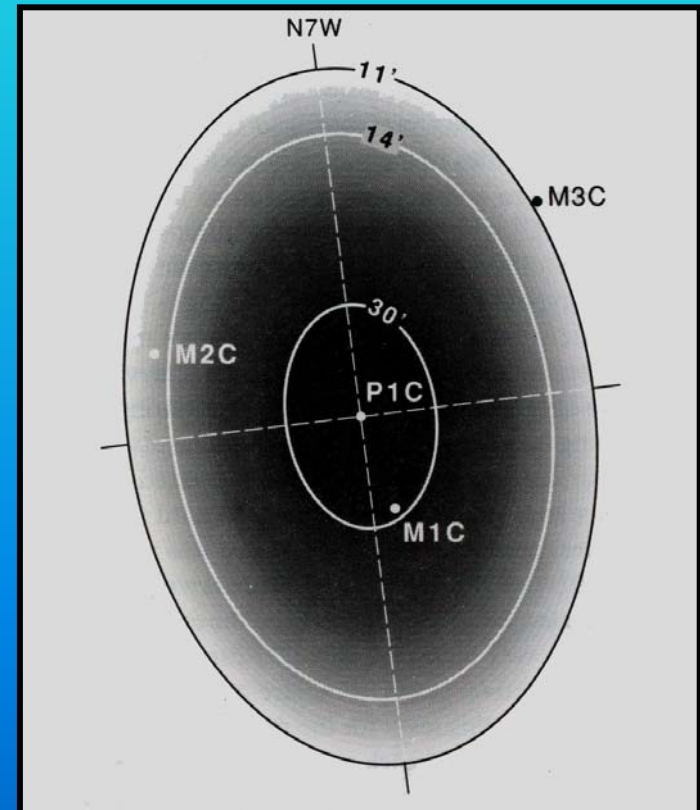


ROCK CREEK PRESSURE BUILDUP TEST RESULTS

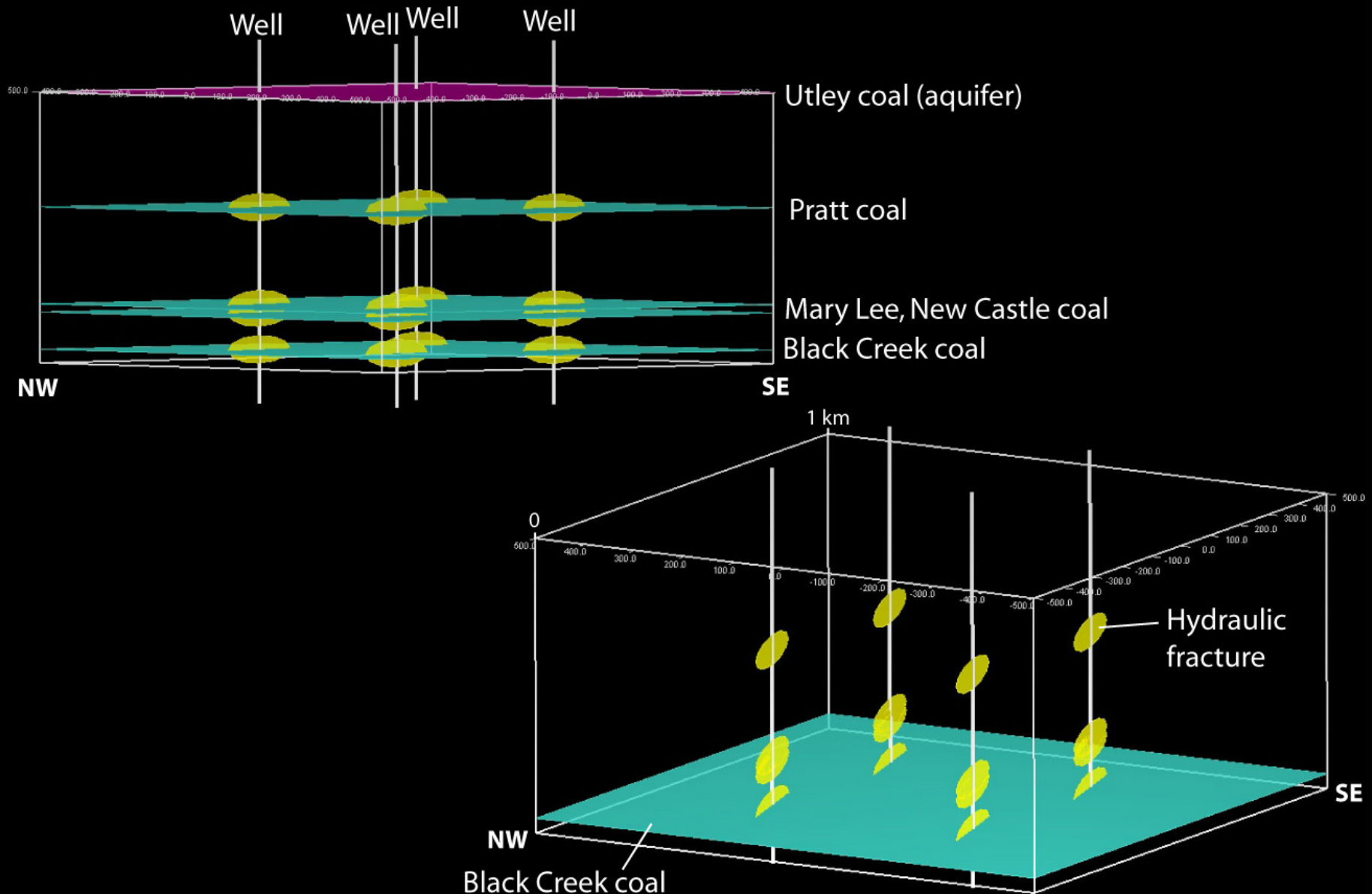
PRATT COAL
(FACE-CLEAT DOMINATED)



BLACK CREEK COAL
(JOINT DOMINATED)



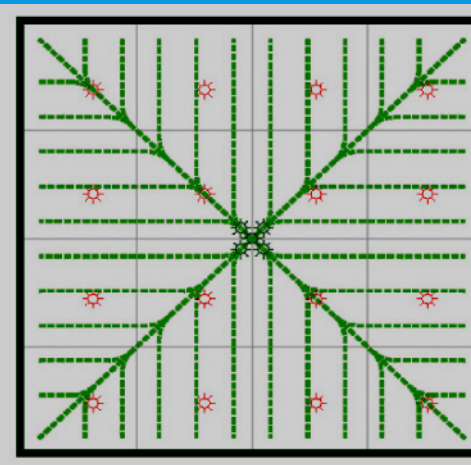
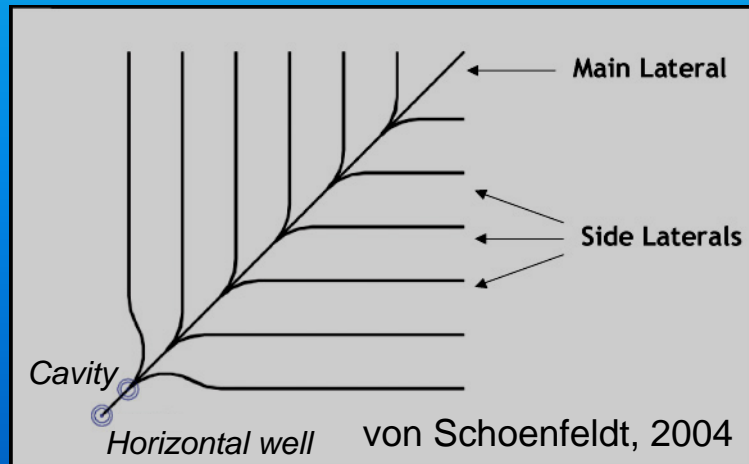
HYDRAULIC FRACTURES AND COAL



The diagram illustrates a coal seam gas well system. A vertical production well is cased with 150mm casing and has a pump at the surface. The horizontal branch hole is drilled down dip, following a radius bend, and intersects the coal seam. A sump is located at the bottom of the vertical well. The diagram also shows a dam, a rig, and a fault line. An inset diagram shows possible branch hole methods to increase in-seam hole surface area.

Field, 2004

Quad Pinnate



CONCLUSIONS

Appalachian sequestration and ECBM potential is in multiple bituminous coal seams distributed through a thick stratigraphic section.

Permeability decreases exponentially with depth, varies by more than order of magnitude at a given depth.

Well performance and permeability are influenced strongly by regional structure.

Diverse multiseam technologies in vertical and horizontal wells required to optimize sequestration and ECBM performance for heterogeneous permeability.